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REVIEW

# Behavior of Scientific Production on Severe Acute Respiratory Syndrome

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## Abstract:

Objective: To analyze the dispersion of journals and scientific collaboration on Severe Acute Respiratory Syndrome, available on the Web of Science. Methods: Bibliometric study that analyzed the production of documents available on the Web of Science, from 1989 to 2020. Results: 1623 documents were retrieved, distributed in 538 journals. The average production per year was 55.9. The average production per author was 1.73. The Nursing category contributed 17 (1.04%) documents, with Virology being the largest contribution 324 (19.96%). China led the ranking with 640 publications (39.43%). Conclusion: The data presented demonstrate the high level of interest of the scientific community in the subject. It was possible to identify 82 authors composing an Elite group of Authors, whose productivity was 66.1%. The United States, China and Saudi Arabia are the countries that most formed Collaboration Networks.

Keywords: SARS, COVID-19, Coronavirus, Bibliometric, Medicine, Nursing.

## Introduction

A new virus from the Coronavirus family, associated with Severe Acute Respiratory Syndrome Coronavirus 2 - SARS-CoV-2, whose clinical manifestation confers with severe respiratory disease, appeared in Wuhan, China, in late 2019 [1-2].

Coronaviruses have been studied by virologists since the mid 1960s. Environmental contamination, potentially caused by SARS-CoV-2 patients through respiratory traps, makes the environment a potential means of transmission, requiring society to adhere strictly to environmental and hand hygiene. In this context, health professionals have been recognized as a high-risk group for Coronavirus infection [2].

The declaration of a pandemic caused by this new virus was announced by Mr. Tedros Adhanom Ghebreyesus on March 11, 2020, since then, the world scientific community is striving to fight the virus and the disease caused by it. Because of the intervening factors of the new Coronavirus pandemic are at the level of multidisciplinary, since it involves aspects of basic and applied sciences, it is observed that researchers from the most different areas of knowledge, are focused on their research in search of an effective treatment and if possible, a vaccine capable of immunizing the human being, therefore, the state of the art of such research may be benefited by studies of this nature [3-4].

We have experienced a century in which information is published and disseminated at an unprecedented scale and speed, making the process of incorporation by researchers increasingly easy [3], therefore, it is essential to have the minimum ability to select the best indexing bases and repositories, prospecting, filter and select the most relevant information for their research, and it is precisely in this context that bibliometric studies present themselves as sources of information for different research areas, and are capable of subsidizing technological and scientific evolution [4], however, due to their characteristic of mapping scientific production [5].

Bibliometric research, which includes the application of statistics to bibliography, has three classically recognized laws: Bradford's Law, Lotka's Law and Zipf's Law [6-7]. The bibliometric studies are based on a set of laws and empirical principles from information science, whose objective is to investigate the quantitative aspects of the production, dissemination and use of available and recorded information, thus contributing to the evaluation of the current state of science, as well as the management of research [6-8].

This study is justified by researching the behavior of the scientific production on SARS-CoV-2, being another contribution to the scientific community interested in studying this serious disease, whose pandemic has led to serious public health, economic and social consequences. The question of this study is: what is the behavior of the scientific production on SARS-CoV-2 in the Science web base? To answer this question through the use of indicators and metrics, the objective is to describe and analyze the behavior of the production of scientific articles on SARS-CoV-2, made available on the Web base of Science.

## Materials and methods

Bibliometric study, of a quantitative nature, based on Bradford's Laws - journal dispersion and Lotka - Law of the inverse of the square, to study the behavior of scientific production and the use of electronically recorded information in an international database, published from 1989 to 2020. The analysis material was limited to documents indexed in the Science web base, for this, all types of documents were used as inclusion criteria. There were no exclusion criteria.

The searches were carried out on the Science web database in April 2020 using the descriptor [Severe Acute Respiratory Syndrome] and with a "title" filter. Access was via the CAPES Journal Portal, using the credentials of the researcher at Rede Cafe. The choice of base is due to its acceptance in the world scientific community, especially in the area of health, which provides summaries and citations of peer-reviewed scientific literature, in addition to providing a more comprehensive view of the world's research production. To perform the bibliometric analysis step, the graphical interface of the VOSViewers® software and the Microsoft Excel 2017® tool were used.

## Results

In this Figure it was possible, based on the Price Law [6-8], to affirm that the proportion of variance explained by the exponential model ($R^2$ = 0,4306) is larger than in the case of the linear model ($R^2$ = 0,0202). Based on these results, we can conclude that publications about SARS show a good fit with the Price Law 6-8 when considering the period (1989-2020). This also shows that the growth of scientific literature in the research area is in the exponential growth stage.

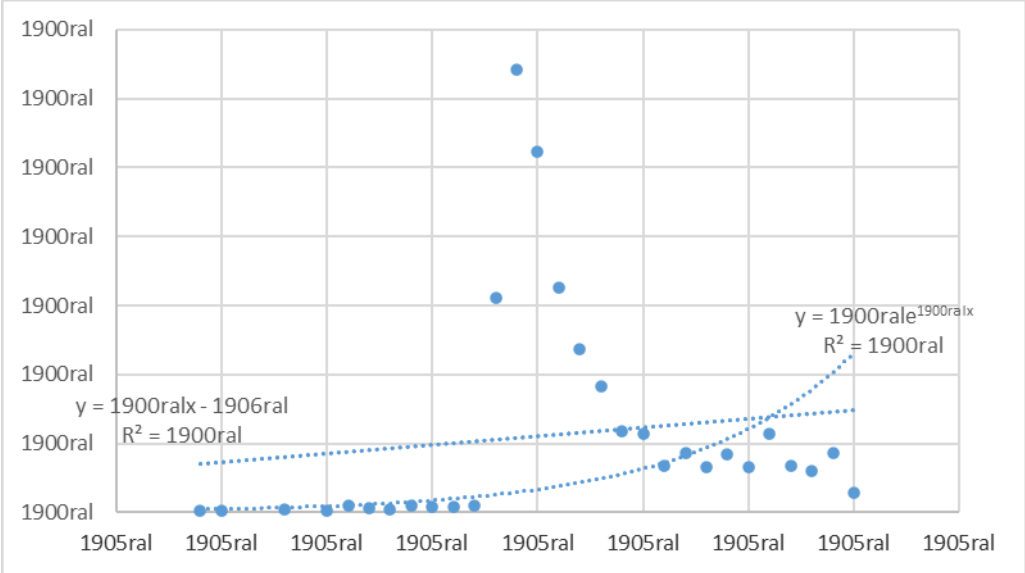


Figure 1 - Chronological distribution of the scientific literature on SARS in the studied period. Linear trend line and exponential trend line. Rio de Janeiro, RJ, Brazil, 2020

We define authorship or contribution as the instance of a researcher as author or co-author of a published article. We follow a complete count, unlike Lotka, who credited only senior or first authors, where each co-author is credited with a complete contribution, regardless of the number of authors. To identify authors and ensure a proper count, a process of disambiguation of names was based on the affiliation of the authors.

There were 7,304 researchers among authors and co-authors. The average productivity was little more than 1.73. The most productive authors/co-authors published 43 articles (2.64%), while the absolute majority, 5,172 (70.81%) published a single article. To identify productivity patterns among authors, Lotka's Law was applied, based on the equation $x^{\alpha} \cdot y = c$, where x = number of

documents published, y = number of authors with x publications and c = constant. Figure 2 represents the equation from the distribution of articles by the number of authors, whose Lotka constant was $0{,}8101X^{-2{,}581}$. The Law of Elitism [3-4] was confirmed from the production of the group of 85 (1.16%) authors/co-authors, whose contribution was 1236 (76.15%) of articles.

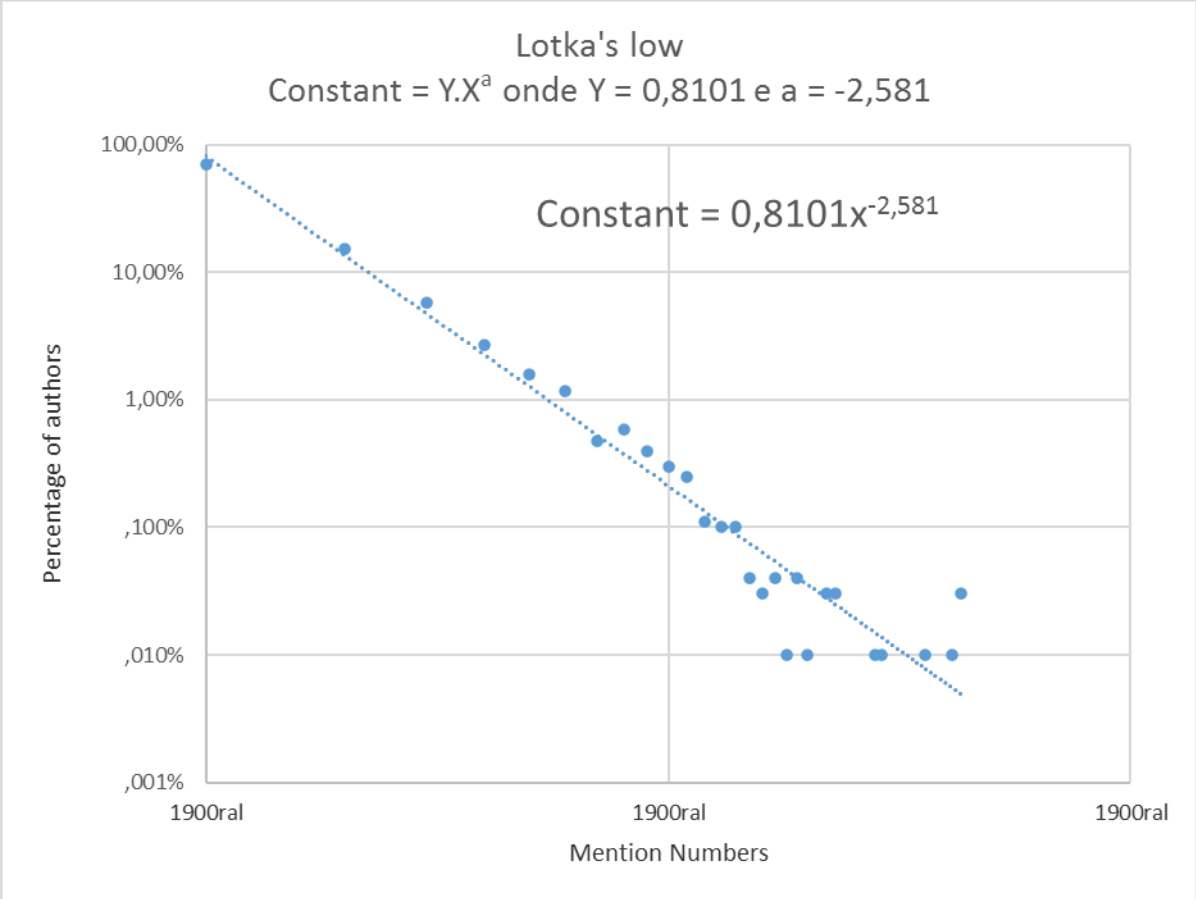


Figure 2 - Illustration of Lotka's Law application. Rio de Janeiro, RJ, Brazil, 2020

The geographic distribution of the publications recovered counted on the collaboration of 66 countries. The absolute leader was China 640 documents (39.43%), followed by the United States 443 (27.29%), Taiwan 158 (9.73%) and Canada 130 (8.01%). Brazil ranks 17th with 10 (0.61%).

The collaborative analysis considered the countries that had at least 5 productions, so only 24 (36.36%) composed the collaborative map (Figure 3). The same number of countries published only one document. Figure 3 represents this distribution, with the formation of six *clusters* divided by different colors. Of this group, Brazil is the only Latin American representative, however, its collaboration only occurs with Italy and Germany, although it shares the same *cluster* with other countries such as Belgium, Spain, France and the Netherlands. This cluster made up of seven countries has published 306 documents, representing 18.85% of the total documents recovered in this study.

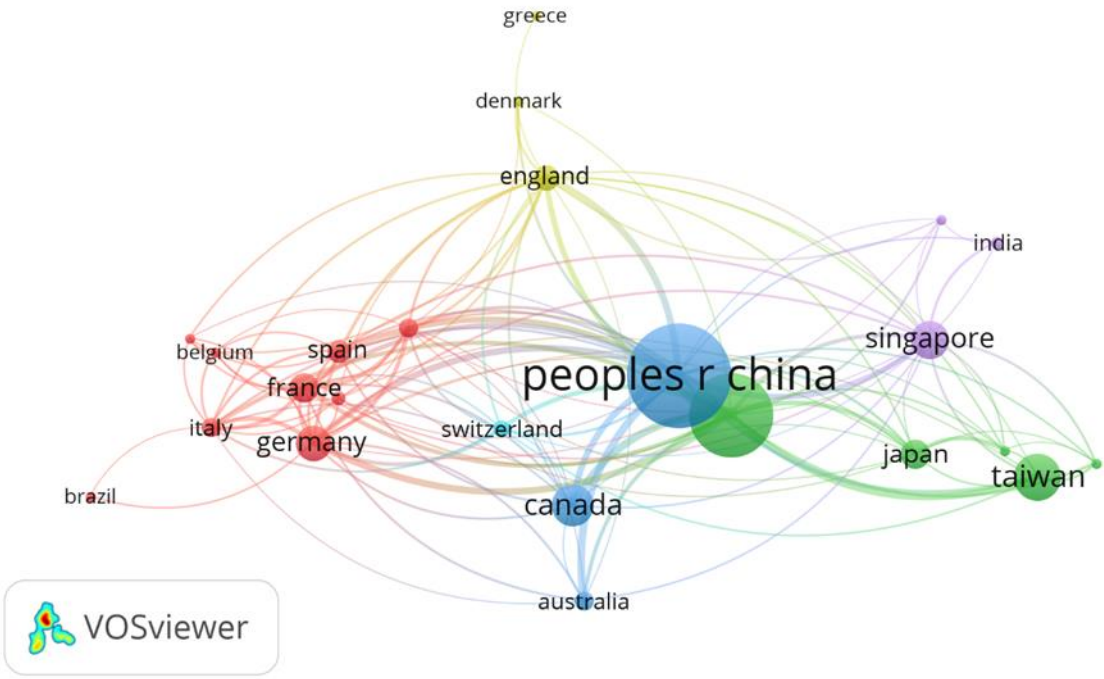


Figure 3 - Map of author collaboration by country, Rio de Janeiro, RJ, Brazil, 2020

The language of publications is concentrated in English, with 1,590 (97.96) documents, then French 11 (0.67%), German 09 (0.55%), Spanish 07 (0.43%), Chinese and Portuguese each with 2 (0.12%), finally Hungarian and Russian each with 01 document (0.06%).

Of the 1586 institutions that contributed to the total number of documents recovered, the first three are located in China, together they published 357 (21.99%), the first being the University of Hong Kong 158 (9.73%). Of the Brazilian institutions, the best ones are the Federal University of Rio de Janeiro - UFRJ with three documents (0.18%), occupying the 274th position and the University of São Paulos - USP in the 464th position with two (0.12%).

Of the 103 categories found, only seven produced 100 or more documents. Virology with 324 (19.96%), Infectious Diseases 208 (12.81%), Immunology 187 (11.52%), Microbiology 172 (10.59%), General Internal Medicine 166 (10.22%), Intensive Care Medicine 139 (8.56%) and Molecular Biology 108 (6.65%). Nursing contributed 17 (1.04%). All documents recovered are distributed in 508 journals, with an average of 3.02 articles per journal. The number of journals that published a single document was 338 (58.2%).

The 1623 SARS documents were published in 532 different journals. After Bradford law enforcement, 15 journals were found in the core, 86 in zone 1 and 532 in zone 2. Tables 1 and 2 present the distribution of the journals and their production, according to the Nucleus the two zones, as well as the values of the Bradford Multiplier (Bm), the latter being calculated to demonstrate that the number of journals contained in the Nucleus is equivalent to the set of journals most devoted to SARS, since its oscillation between the zones did not exceed the maximum value of 0.7.

Bradford's premise [8-9] is that scientific journals should be organized in decreasing order of productivity of documents on a particular subject, that the whole should be divided into a core of journals more particularly dedicated to the

subject and several groups or Zones that should contain the same number of documents as the core, then the number of journals in the core and in the successive Zones, will be the proportion *1:n:n2:n3...*

For the purpose of distribution of the Nucleus and the zones, in this study, the value proposed in the theory was used, thus, the Nucleus and each of the two zones, accounted for approximately 1/3 of the total number of documents produced in the time clipping analyzed, that is, approximately 541 documents in the Nucleus, 1082 in zone 1 and 1623 in zone 2 (Table 3). The 15 journals that compose the Nucleus have Impact Factor (IF) in the WOS: Journal of Virology (FI = 4.324), Chinese Medical Journal (FI = 1.555), Journal of Clinical Microbiology (FI = 4.959), Journal of Infectious Diseases (FI = 5.045), Journal of Biological Chemistry (FI = 4.106), Proceedings of the National Academy of Sciences of the United States of America (FI = 9.58), Clinical Infectious Diseases (FI = 9.055), Journal of General Virology (FI = 2.809), Critical Care Medicine (FI = 6.971), Emerging Infectious Diseases (FI = 7.185), American Journal of Respiratory and Critical Care Medicine (FI = 16.494), Virology (FI = 2.657), American Journal of Roentgenology (FI = 3.161), Clinical and Diagnostic Laboratory Immunology (FI = 2.511), Intensive Care Medicine (FI = 18.967).

Table 1 - Bradford Classic Table, Rio de Janeiro, RJ, Brazil, 2020

| Number of periodicals | Article Production | Accumulation of journals | Accumulation of articles | Productivity Zone |
|---|---|---|---|---|
| 1 | 216 | 1 | 216 | |
| 1 | 40 | 2 | 256 | |
| 1 | 32 | 3 | 288 | |
| 1 | 31 | 4 | 319 | |
| 2 | 29 | 6 | 377 | |
| 2 | 24 | 8 | 425 | Center |
| 1 | 23 | 9 | 448 | |
| 1 | 21 | 10 | 469 | |
| 1 | 18 | 11 | 487 | |
| 1 | 17 | 12 | 504 | |
| 3 | 16 | 15 | 552 | |
| 2 | 15 | 17 | 582 | |
| 2 | 14 | 19 | 610 | |
| 4 | 13 | 23 | 662 | |
| 1 | 12 | 24 | 674 | |
| 2 | 11 | 26 | 696 | |
| 2 | 10 | 28 | 716 | Zone 1 |
| 2 | 9 | 30 | 734 | |
| 2 | 8 | 32 | 750 | |
| 9 | 7 | 41 | 813 | |
| 9 | 6 | 50 | 867 | |
| 17 | 5 | 67 | 952 | |
| 19 | 4 | 86 | 1028 | |
| 35 | 3 | 121 | 1133 | |
| 79 | 2 | 200 | 1291 | Zone 2 |
| 332 | 1 | 532 | 1623 | |

Source: research data

Table 2. Bradford, Rio de Janeiro, RJ, Brazil, 2020 zones

| Zones | Number of Articles | Number of Periodicals | Proportion | Bm* |
|---|---|---|---|---|
| Núcleo | 541 | 15 | 1 | |
| Zona 1 | 1082 | 86 | n | 5,733333 |
| Zona 2 | 1623 | 532 | n*2 | 6,186047 |

Bm* Bradford Multiplier

## Discussions

For this study, a worldwide bibliometric analysis on SARS was performed for 31 years. This long period, together with the exhaustive nature of the bibliometric research, allowed us to correctly apply methods and bibliometric indexes in order to reduce the relativity of the data as much as possible.

After these analyses, it was possible to prove that the corpus of the research is consistent, since the mining of the data allowed the recovery of the documents from the main descriptors, delimiting the subject that was the focus of the research. The quantity of 1623 documents, surpassed other bibliometric studies in the health area, such as, for example, on scientific production on moral harassment/moral harassment with 53 documents recovered in the period from 2002 to 2012 [10] and another one on virtual reality in venipuncture, which analyzed the 213 documents recovered in the same database, from 1969 to 2018 [11]. This result reflects greatly the interest of the scientific community about the pandemic, as well as its emergence in the world scenario [12].

When compared to studies in the obstetrics area, it represents a surprisingly small proportion, when compared to the time cut from 2002 to 2013, reaching 142,659 articles and 9967 clinical trials recovered [13]. However, the sample showed an exponential growth, in spite of the complexity of conducting studies involving viruses: they require advanced knowledge of methodology and considerable funding and are very time consuming.

A significant increase was observed in the period from 2003 to 2007, motivated by the SARS epidemic, which killed hundreds of people in 2002 and 2003 and hit hardest economies in Asia [13]. The trend is for the period 2020 to 2023 to repeat the same performance observed in 2003 to 2007. Pointing once again to the emergence of the subject and the curve of interest by the scientific community, indicating that the average life has not yet reached saturation point. It also allows us to affirm with certainty that the rate of thinning or the substitution of scientific knowledge on this subject is still far from being initiated, in the same way as the aging/obsolescence factor, since there was no loss greater than 50% in the citations and in the actuality of the information [5,10,14].

Transition rates and productivity of authors provide interesting data; the number of occasional or transient authors is lower in disciplines where scientific activity is well established, which means that a high transition rate reflects the lack of relevant working groups, although it may also indicate the presence of researchers from other scientific areas. A transience index of 70.81% was obtained, and from highly productive authors 1.16% was very close to the study on obstetrics [13], whose values are, respectively, 71.5% and 1.33% of the total.

Applying Lotka's law, it is possible to identify an inversely proportional relationship between the number of authors and articles produced. Nevertheless, the constant found in Figure 2 confirms the postulate that represents the thought

'many with little and few with much (7-10), since the greater the number of articles produced, the smaller should be the number of authors. This research result overcomes the limitations imposed by the biosafety level 4 requirement for SARS research, and directly related to increased funding for studies of infectious diseases such as HIV/AIDS. Funding has been reported to have a positive influence on research outcome and citations of a specific disease [14].

By applying the Law of Elitism of Price [10], it was possible to identify the Elite Group of authors, considering that the square root of the total number of authors was 82, a total of authors representing the elite of the studied area, since their production represents 66.1% of the documents recovered, exceeding by far the minimum of 50% Proposed in the Law of Elitism, in which weight the fact that the productivity index has been very low 1.65, largely as a consequence of the excessive number of occasional authors [10].

The co-authorship analysis made it possible to verify the strength of scientific collaboration between those authors/co-authors who produced at least 5 documents with at least 10 citations, the majority of which make up the Elite Group. Co-authorship analysis is an important bibliometric indicator, being one of the most researched attributes in the utilization of Social Network Analysis (SNA), as it provides the researcher with a broad view of the invisible schools in which the vertices of research are immersed, besides a series of other findings regarding union relations in the scientific field [8-10]. Teamwork becomes essential, considering the multifaceted nature of contemporary research and the cost implications.

In this respect, when we compare the average co-authorship with the institutions and countries of origin, it is possible to see that Social Networks in the scientific field are globalized between authors, affiliations and countries, once again led by the United States of America and Eastern countries, in particular China and Saudi Arabia, followed by the United Kingdom and Germany. Brazil stands out as the 21st position, the only representative of Latin America. The language of publications was dominated by English. This dominance can be easily explained, as English is a universal language for science. This finding allows us to safely infer that the level of international interaction of Brazilian researchers is still in a phase of consolidation.

Applying the Bradford's Law to verify the behavior of the distribution/dispersion of journals, in Table 3, it was possible to identify, from the Bradford Multiplier (Bm), a constant, since the variation between the Bm of the Zones remained within the allowed oscillation [5-9] 0.7, demonstrating a distribution very close to the ideal ($I:n:n^2$), as determined by the Law. The Nucleus comprised 15 periodicals, being these the most devoted to the subject [9-10].

## Conclusion

SARS represents a small proportion of the total scientific production in the health area, however, its coverage in the area was quite representative. Since this is a very current subject, when considering the temporal cut-off, it is reasonable to state that the quantity of documents recovered is quite relevant when compared to other bibliometric studies in the health area.

Researchers can benefit from bibliometric analysis techniques, not only in a quantitative approach, but also in a qualitative one, because the numbers help in

the approximate reading of reality and, with the inclusion of more in-depth studies, the richness of the analyses becomes more representative. Therefore, bibliometric studies can contribute to the visualization of the connections between information from several areas of knowledge.

Although based on empirical facts, the laws of *Bradford* and *Lotka*, succeeded in this study to confirm possible theoretical hypotheses that the Nucleus of journals is formed by the most devoted and, therefore, more productive, nevertheless, revealed that the greater the specificity of the subject studied, the greater the possibility of identifying groups of authors.

As the classical formulation of the Law was used, it was predictable that the adjustment would not be perfect, since n variables influence the empirical distribution of the literature. These variables are not captured by Bradford's classical formula, and represent the greatest challenge to contemporary scholars of its mathematical formulation. The core pointed out from the application of the Law perfectly recognized an important aspect related to the scientific academic behavior on SARS, that is, when there is evidence that certain journals are or will be recognized in the environment, more and more publications are directed to it, for this, it would be important to verify the qualitative aspect of these journals, based on the impact factor indicators, these would be the most reliable.

Because Lotka's Law provides a platform to measure the productivity patterns of authors over a given period, it is known that each area of a discipline can be associated with an exponent, representing its specific rate of productivity of the author. This is not enough to explain why one individual should be more productive in producing dozens of published articles on a subject, another individual produces few works and a third individual produces none.

The discrepancy in the author's productivity can be partially explained by the context of each individual. For example, author productivity is not linked to collaborative authorship, but collaborative authorship can influence an author's productivity during a given period, as was the case with this research when considering all authors and co-authors, perhaps this can explain in this study, the framing of the law of the inverse square and an Elite Group of authors.

As a contribution, the results of the study and its methodological design may serve as a basis for other propositions, thus filling a gap in the list of bibliometric research in health, especially in nursing, such as the commitment to consolidate its body of knowledge, developing research that can simultaneously contribute to the growth and consolidation of this knowledge.

We highlight some limits to the methodological approach in the present research, including the use of a single research, the difference in sensitivity of the descriptor selected for the search of documents that appear in the title. The exclusivity of these findings may be due to the use of only one database. Thus, future searches may include the examination if the extent of the co-authoring productivity pattern increases if more articles are sampled in different databases. Despite these shortcomings, some results of this study seem interesting and worthy of further discussion.

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